DEVELOPING A COURSE AND WORKSHOP TO MAXIMIZE TEACHING POTENTIAL

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Abstract – *We undertook an investigation to determine whether topics in a typical education course would be useful to bioengineers preparing for an academic career in post-secondary institutions. Teaching is a major responsibility if bioengineering professors. Little or no preparation is provided in this area, and yet there is an extensive educational research knowledge base that can inform their teaching. We began by analyzing an existing graduate education course designed to provide an overview and understanding of the principles of effective teaching and learning, and determined key content topics relevant to the teaching of bioengineering. Based on this course analysis, we revised course content and taught a special section of the course specifically for bioengineering and science graduate students. We later distilled the course into a two-day workshop for bioengineering graduate students, post-doctoral fellows, and professors; thus far we have tested the workshop at three different sites.*

Index Terms – bioengineering, education, teaching, teaching and learning.

POST SECONDARY TEACHING: EXPECTATION VS. PREPARATION

There exists a wide discrepancy between teaching preparation and teaching expectations of new post secondary faculty. Knowing is one thing; teaching is another. The education and experiences of a student earning a Ph.D. focus entirely on knowledge within that discipline and skills needed to further that knowledge. The neophyte professor is not prepared for the teaching of this discipline -- the most effective ways of not only transmitting facts and concepts to others, but also of engaging others in thought processes that result in lasting learning.

Many students earning Ph.D.s in various fields of engineering and science aspire to successful post-secondary positions that require expertise in both research and teaching. During their time as graduate students they work on one to several research projects (indeed, the required dissertation is typically based on their work in such a project), receive mentorship in grant writing, and likely serve as a teaching assistant (TA) (i.e., paper grader, resource finder, tutor, and convener of special study sessions). As a TA, it is possible they may receive a one-day session on TA expectations and requirements – and that is it for teaching preparation.

Yet there exists a solid research base on effective teaching and learning in the K-12 area [1, 2], the majority of which is applicable to human behavior at all age levels. The knowledge to assist new professors to become effective teachers exists, but access to this knowledge is not currently available to graduate students preparing to enter the field of post secondary education..

DEVELOPING AN EDUCATION COURSE FOR BIOENGINEERING GRADUATE STUDENTS

The goal was not to reinvent the wheel, but rather to find a wheel currently in the education program and adapt it to fit the terrain of students preparing to become professors of bioengineering.

The Pre-existing Wheel

For the past ten years Peabody College of Education at Vanderbilt University has offered a graduate education course designed for graduate students concurrently seeking a masters degree in education and teaching licensure: *Education 3500.01, Seminar on Teaching and Schools*. These students come with undergraduate and graduate degrees in a variety of areas (including business, chemistry, English, engineering, French, geography, history, law, marine biology, marketing, physics, etc.), and no background in education. The course has among its goals to give these educational neophytes a grounding in key aspects of education (e.g., history, learning theory, philosophy, instructional models and strategies) and to bring them abreast of current research-based knowledge in education. The course was developed at Peabody Vanderbilt specifically for the masters-plus-certification program, and is similar in several ways to educational foundations courses found at other schools of education.

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Hypothesis, Analysis, and Adaptation

We hypothesized that the ED3500.01 course could be adapted for bioengineering graduate students, and could provide them with a foundation for effective teaching as a beginning faculty member. Like the ED3500.01 students of past years, they would come with an undergraduate and/or graduate degree in a specific subject area and no educational background. Therefore, the current class topics would be appropriate. However, unlike the ED3500.01 students, they would not take any additional education courses in specific teaching and learning strategies. Thus, some areas important to teaching and learning should involve more depth, while others would be touched lightly or omitted. Our task was to develop a stand-alone education course that would provide a solid foundation upon which beginning boengineering professors could build their classroom teaching at the college level, and thus provide them with a head start in the teaching portion of their university career.

The questions became which areas to emphasize, which ones to de-emphasize, and which ones to omit. A course analysis committee of four set out to answer these questions: one education professor, one biomedical engineering professor, one biomedical engineering graduate student (who was a certified and experienced high school math teacher) and one computer engineering graduate student interested in learning and technology. The two students participated in the ED3500.01 course for the entire semester, and the committee met each week to discuss what topics and activities from the week's lessons should be included, adapted, emphasized, de-emphasized, and omitted for a bioengineering-focused course. The committee used a 1-to-5 rating scale to rank the value of each topic and subtopic of the syllabus, with the rank based on the importance for teaching preparation of future bioengineering faculty. At the end of the semester we had an outline of selected and prioritized key concepts (see Table I), and ideas for further adaptation within that list.

TABLE I
SELECTED TOPICS FOR ED3500.02

Topic	Kept	Adapted	Omitted	Added
Changes in K-12 Education			X	
Classroom Culture	X			
Human Development		X		
Excellence and Equity			X	
Philosophical Contexts	X			
Political Contexts		X		
Historical Contexts		X		
Learning Theories	X			
Curriculum		X		
Models of Learning		X		
Act of Teaching	X			
Effective Teaching Practices	X			
Life and Work of Professional Teachers			X	
Trends in Bioengineering Education				X

Presenting and Reviewing the Course

Based on the consensus of the committee of four, we modified the existing education course and offered ED3500.02 as an education preparation course for graduate bioengineering students.

Students in the Class

Although the course was designed originally for bioengineering graduate students, they were joined by others from various science fields who were participating in the NSF-sponsored Graduate Teaching Fellows in K-12 Education (GK-12) program. These students were working twice each week in public school secondary science settings teaching science labs. The final class roster of eleven included students seeking advanced degrees in biomedical engineering, chemistry, biology, physics, and pathology; and included students from both Vanderbilt University and Meharry Medical College.

The Course: Content and Evaluation

The course met for fifteen weeks, once each week for a three-hour session. The content of the course is reflected in Table I. All lecture slides and notes were available to students through the web, both before and after a given class session. Students in the GK-12 program carried out various practica in the schools where they taught; nonteaching students observed in university classes. Activities within the course included lectures, discussions, student-led presentations, student formulation of content questions, media presentations, school site visits and observations, media presentations with written responses, short reflection papers, journals of teaching experiences (for those teaching in schools), an opinion paper, and examinations.

Student evaluations. As both the ED3500.01 for education students and ED3500.02 for bioengineering and science students were taught by the same professor during the semester, it was possible to make a comparison. Two of the twenty evaluation questions provide a summary of students' evaluation: (1) Estimate how much you learned in this course, and (2) Give an overall rating of the course. We compared the bioengineering and science students' evaluation of the ED3500.02 course against the education students' evaluation of the ED3500.01 course, and also against the Peabody college-wide evaluation average for all courses during that semester. Student evaluations indicated definite learning gains and a positive perception of the course (see Figure 1).

Teacher evaluations. A comparison of grades earned in both the ED3500.01 course for education students (N=18) and the ED3500.02 course for bioengineering and science students (N=11) indicate similar content mastery for both groups, with both the mean and median grades of the two

classes within two points of one another, and the grade range within three points. Standard deviation for the ED3500.01 grades was 3.23; for the ED3500.02, 4.52. Assignments for the two classes were similar, but differed in focus as needed to meet the needs of those students pursuing K-12 teaching versus those pursuing post secondary teaching. Exams were likewise similar in form and content, and differed only in education-level focus. Students in both courses availed themselves of the on-line resources about equally.

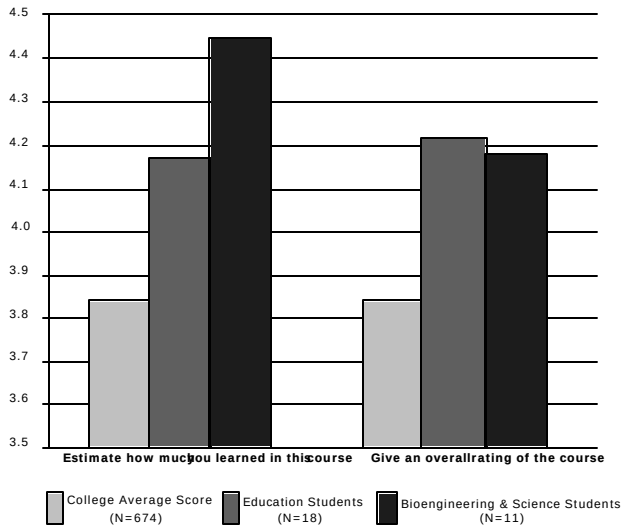

FIGURE. 1
STUDENT COURSE EVALUATIONS ON TWO SUMMARY INDICATORS

DISTILLING THE COURSE INTO A SEMINAR

Several sister programs of bioengineering studies learned of the course we developed for bioengineering graduate students and requested that we work to distill key concepts into a transportable two-day seminar. As not all schools of engineering necessarily have access to a similar course – or an education professor with both interest and time for developing and teaching such a course, a short seminar could perhaps teach, refresh, and invigorate. We purposed to develop a seminar appropriate for graduate students (especially those new to a teaching assistantship), post doctoral fellows, and both new and veteran professors.

Two of the four members of the original course analysis committee (the education professor and the biomedical engineering graduate student with teaching licensure and secondary teaching experience) now worked to refine the previously identified essential concepts and skills of teaching and learning to fit a two-day experience rather than that of a semester. Using the "backward design" as explained by Wiggins and McTighe [3], they developed the seminar curriculum by considering possible content as falling into one of the three levels of curricular importance: *enduring understanding*, *important to know and do*, and *worth being familiar with*. Also, informal input from the bioengineering and science students completing the ED3500.02 course guided decision making on the seminar content. The final agenda of the seminar is presented below (see Table II).

TABLE II
SELECTED TOPICS FOR A TWO-DAY SEMINAR ON TEACHING AND LEARNING

Session	Topic
One	Introduction: Education Today – K-16
Two	Bioengineering: Present, Past, and Possibilities
Three	Human Development: Students Whom We Teach
Four	Teaching Philosophy: Professors and TA's Who Teach
Five	Culture: Recognizing and Creating Elements of Culture
Six	Learning Theories: How Do We Learn?
Seven	Content: The Knowledge, Skills, and Values We Teach
Eight	Curriculum & Lessons: Scope and Sequence
Nine	Effective Teaching Practices: There Is a Research Base

TESTING THE SEMINAR

We tested the workshop in departments of biomedical engineering at three university sites (Vanderbilt University, Northwestern University, Duke University) with a mixed audience of professors, post doctoral fellows, and graduate students. At Vanderbilt we spread the workshop components over a three-day period to accommodate other campus activities required for teaching assistants; at the other two sites we followed the two-day format. Participant numbers ranged from nine to fourteen (see Table III).

TABLE III
PARTICIPANTS IN A TWO-DAY SEMINAR ON TEACHING AND LEARNING

University	Professors	Post Doc Fellows	Graduate Students
Vanderbilt	6	0	8
Northwestern	4	1	8
Duke	3	1	6
Total	13	2	22

Participants took both a pre- and post-test designed to measure their knowledge of key ideas and concepts in education before and after the workshop. Data from the three workshops indicate participants gained "head knowledge" about the educational topics presented.

Participants were provided with a workshop manual of both information and activities that they used during the workshop and took with them for future reference.

Future Directions

We plan to continue dissemination of the seminar, but we see a need for additional methods for data collection on its effectiveness. Although we have received positive reports from both professors and graduate students about their application of teaching and learning ideas gained in the seminar, we currently have in place no system to methodically collect such data. We hope to develop a method of following up with workshop participants on their application of seminar ideas in their teaching.

References

[1] Berliner, D. & Calfee, R., eds., *Handbook of Educational Psychology*, Simon and Schuster Macmillan, New York, 1996.

[2] Sikula, J., Buttery, T., & Guyton, E., Eds., *Handbook of Research on Teacher Education*, Simon and Schuster Macmillan, New York, 1996.

[3] Wiggins, G. & McTighe, J., *Understanding by Design*, 1Association for Supervision and Curriculum Development, Alexandria, Virginia, 1998.

[4] Bransford, J., Brown, A., & Cocking, R., eds., *How People Learn: Brain, Mind, Experience, and School*, National Academy Press, Washington, D.C., 1999.